InterCEL Pty. Ltd. A.C.N. 007 077 161
33 Glenvale Crescent Mulgrave VIC. Australia 3170
Email : intercel@intercel.com.au
Internet : www.intercel.com.au
Ph: +61 3 9561 1666 Fax: +61 3 9561 2614

THE GSM EMBEDDED MODEM USER'S GUIDE

History:
Created: 10th Oct 2001 Version 1.0 (sv)
Date 28th Mar 2002 - Version 1.1: Modifying the 44-pin connector pinouts (sv)
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Date 20th Jun 2002 - Version 1.3: Add details to all signals, remove the development board (sv)
Date 26th Jun 2002 - Version 1.4: Add General guide-lines (sv)

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Internet : www.intercel.com.au
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1 Introduction

The GEM is designed to provide a quick and easy solution to systems that need to access GSM/GPRS network/functionality. The GEM is full type approved and ready to use. It employs the proven GSM WISMO™ technology from WAVECOM.

1.1 Scope of this manual

This document describes the hardware interface and the technical specification of the GEM. For information about controlling the GEM via the AT commands, refer to the ' AT command manual'.

1.2 Electrical characteristics

- Dual band GSM modem E-GSM 900/1800 or E-GSM 900/1900
- Class 4: 2W for GSM 900
- Class 1: 1W for GSM 1800/1900
- Voice, SMS, Fax and data
- Tricodec: Full Rate, Enhanced Full Rate and Half Rate
- 3V SIM interface
- Power supply: 3.6V to 4.2V @ 2A
- 300mA average in communication mode
- 4mA in idle mode
- Operating temperature: -20°C to + 55°C
- Storage temperature: -35°C to +85°C

1.3 Mechanical characteristics

- Small size: 62mm(L) x 38mm(W) x 12mm(H)
- Weight: 25g
- Casing: ABS Plastic
- Mounting: 3 screw holes

1.4 Features

1.4.1 Telephony

- Telephony (TCH/FS) and Emergency calls
- Full Rate, Enhanced Full Rate and Half Rate
- DTMF functions

1.4.2 Short Message Service

- Point to Point MT and MO
- SMS Cell Broadcast

1.4.3 Data

- Data circuit asynchronous, transparent and non-transparent up to 14.4kbps
- Automatic fax group 3 (Class 1 and Class2)
- Alternate speech and fax
- MNP2, V.42bis

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1.4.4 GPRS packet data features

- GPRS class 2 / Class B (2Rx/1Tx, GSM/GPRS switchable)
- Coding schemes CS1 to CS4
- Compliant with SMG31bis

1.4.5 GSM Supplementary Service

- Call Forwarding
- Call Barring
- Multi Party
- Call Waiting and Call Hold
- Calling Line Identity
- Advice of Charge
- USSD
- Closed User Group
- Explicit Call Transfer

1.4.6 Others

- ME + SIM phone book management
- Fixed Dialling Number
- SIM Toolkit Class 2
- SIM, network and service provider locks
- Real Time Clock
- Alarm management
- Software upgrade through Xmodem protocol
- UCS2 character set management

1.5 Interfaces

- Single Antenna Interface
- 3V only internal SIM interface
- 44-pin general purpose connector
- Serial RS-232C link: 300bps to 115200 bps

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2 RF safety

2.1 General

The GEM is based on the GSM standard for cellular technology. It is a low power radio transmitter and receiver. It sends and receives radio frequency energy. The GEM radio frequency and transmit power levels are controlled by the cellular system.

2.2 Exposure to RF energy

There has been some public concern about possible health effects of using GSM modem. After all existing researches have been reviewed and all applicable safety standards have been met, the modem is fitted for use.

If exposure to RF energy is still the main concern, there are ways to minimize the exposure: Positioning the antenna and limitting the duration of the calls.

2.3 Efficient modem operation

For the modem to operate at the lowest power level, use the correct antenna and place the antenna at the position where it gets the best possible signal strength. Do not hold the antenna while the modem is in a call.

2.4 RF interference

Most of the electronic equipments are shielded against RF energy. However, RF energy may affect some equipment that is inadequately shielded. To use the modem near particular electronic equipment, check with the manufacturer's shielding specifications.

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3 Standard Compliance

The GEM meets the following standards

3.1 GSM Phase II compliance

- EN 301 419-1, (GSM 13.01) April 2000, Version 4.1.1
- EN 301 420 (GSM 13.02) December 1999, Version 4.0.1
- ETS 300 607-1, (GSM 11.10-1) September 2000, Version 4.28.1
- GT.01, December 2000, Version 4.7.0

3.2 Safety

- EN 60950: 2000 (3rd edition) : Safety of information technology equipment

3.3 EMC

- EN 301 489-7: 2000
- EN 301 489-1: 2000
- EN 50081-1: 1992
- EN50082-1: 1997

3.4 FTA compliance

The GEM has received a Full-Type approval (according to normal MS requirements) in the configuration using the internal SIM interface.

3.4.1 IMEI number

- TAC: 500246
- FAC: 66
- Serial number: 000000 to 999999

3.4.2 CE label

The GEM is CE compliant, which implies that the modem is in conformity with the European Community directives and bears the CE label CE0681

3.5 ACA compliance

The GEM has been declared to be ACA compliant. It bears the A-tick mark and C-tick mark, which enables it to be used in Australia and New Zealand

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4 RF specifications

4.1 RF architecture

The RF part is based on a specific dual band chip and includes:

- 2 dedicated down converters
- IF demodulator
- All local RF & IF VCO
- PLL
- Transmit loop (modulator, down mixer, phase frequency comparator)
- 2 power amplifiers

4.2 RF frequencies

The RF functionalities comply with the Phase II EGSM 900/GSM 1800 or GSM 1900 recommendation:

- Rx (EGSM): 925 to 960MHz
- Tx (EGSM): 880 to 915MHz

- Rx (GSM 1800): 1805 to 1880MHz
- Tx (GSM 1800): 1710 to 1785MHz

- Rx (GSM 1900): 1930 to 1990MHz
- Tx (GSM 1900): 1850 to 1910MHz

4.3 RF performances

4.3.1 Receiver

- EGSM 900 sensitivity: < -102 dBm
- GSM 1800/1900 sensitivity: <-102 dBm
- Selectivity @ 200 KHz: > 9 dBc
- Selectivity @ 400 KHz: > 41 dBc
- Dynamic range: > -43 dBm
- Co-channel rejection: >= 9 dBc

4.3.2 Transmitter

- Maximum output power for EGSM 900: 33dBm ± 2dB
- Maximum output power for GSM 1800/1900: 30dBm ± 2dB
- Minimum output power for EGSM 900: 5dBm ± 5dB
- Minimum output power for GSM 1800/1900: 0dBm ± 2dB
- H2 level: < -30 dBm
- H3 level: < -30 dBm
- Phase error at peak power: <5° RMS
- Frequency error: ± 0.1 ppm max

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5 Hardware Description

5.1 Overview

The GEM includes a Wavecom Wismo3 module, a 44-pin header, a SIM-card holder and a RF connector.

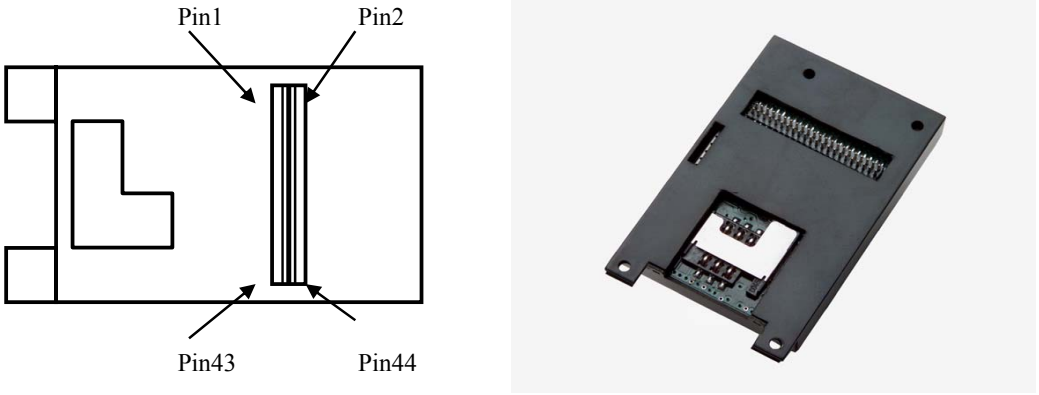

Figure 1: GEM bottom view

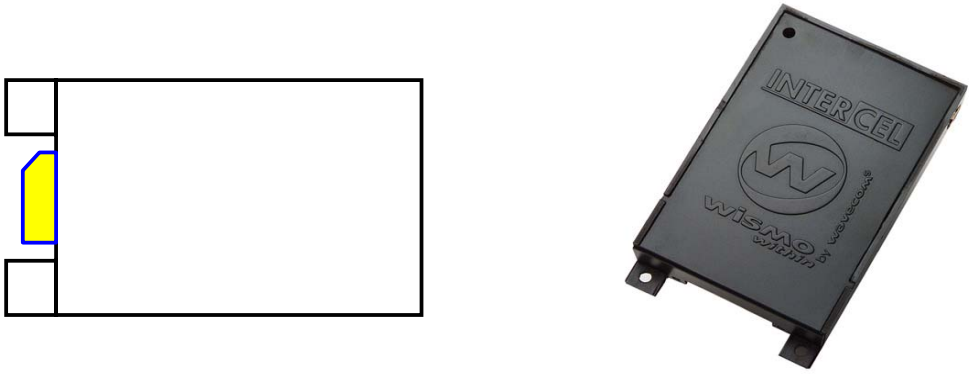

Figure 2: GEM Top view

Figure 3 : GEM side view

- GEM connector : Samtec 44-pin high density header
- Antenna connector: MMCX socket

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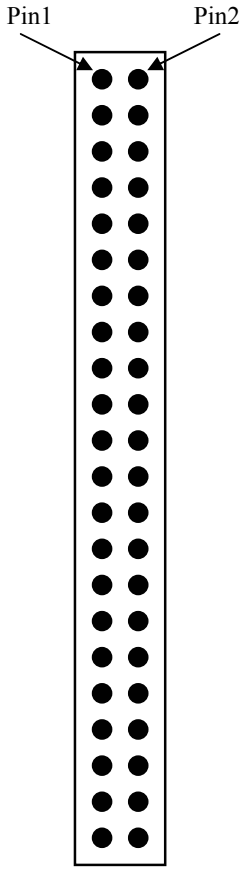
5.2 The 44-pin connector

This connector consists of all signals, necessary for system integration. It consists of serial RS232 signals, audio input/output, general I/O, keypad, power supply and GEM control signals.

Pin number	Signal	Description
1	GND	Ground, high current
2	ON/OFF	Input, modem on/off control signal
3	GND	Ground, high current
4	RESET	Input, modem reset control signal
5	AUXV0	Analogue input signal
6	BUZZER	Buzzer output
7	MIC2+	Microphone2, positive input
8	SPEAKER2+	Speaker2, positive output
9	MIC2-	Microphone2 negative input
10	SPEAKER2-	Speaker2, negative output
11	RTS	RS232 interface, input
12	DTR	RS232 interface, input
13	RXD	RS232 interface, output
14	DSR	RS232 interface, output
15	TXD	RS232 interface, input
16	CTS	RS232 interface, output
17	DCD	RS232 interface, output
18	RI	RS232 interface, output
19	BOOT	Input control signal
20	GPIO4	General Purpose input/Output 4
21	VCC_RTC	Supply voltage to Real-Time clock
22	GPIO5	General Purpose input/Output 5
23	GPIO0	General Purpose input/Output 0
24	LED	Output, Working Indication
25	SIM_PRES	Input, SIM card detect
26	SIM_DATA	I/O , SIM data
27	SIM_CLK	Output, SIM clock
28	SIM_RESET	Output, SIM reset
29	SIM_VCC	Output, SIM card supply voltage
30	SPI_CLK	Output, SPI clock
31	SPI_EN	Output, SPI enable
32	SPI_IO	I/O, SPI data
33	Key_Row0	I/O, Keypad Row 0
34	Key_Column0	I/O, keypad Column 0
35	Key_Row1	I/O, Keypad Row 1
36	Key_Column1	I/O, keypad Column 1
37	Key_Row2	I/O, Keypad Row 2
38	Key_Column2	I/O, keypad Column 2
39	Key_Row3	I/O, Keypad Row 3
40	Key_Column3	I/O, keypad Column 3
41	Key_Row4	I/O, Keypad Row 4
42	Key_Column4	I/O, keypad Column 4
43	3V6	Supply voltage
44	3V6	Supply voltage



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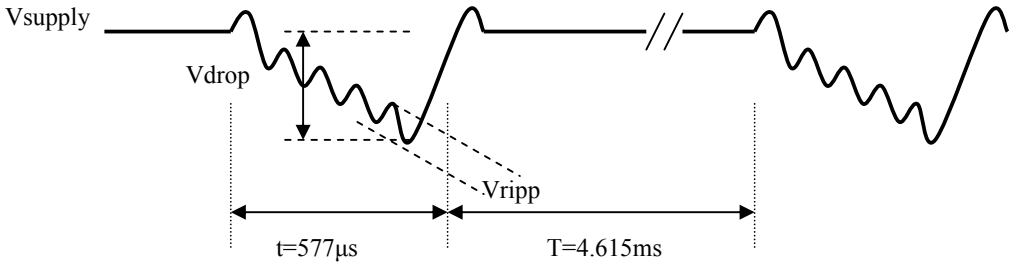
5.3 Signal description

5.3.1 Power supply:

Pin1/Pin3 = Supply Ground.
Pin43/Pin44 = Supply input voltage

Power supply design is an important factor. In communication mode, the GSM modem transmits in burst sequences (577µs burst every 4.615ms), therefore the power supply must be able to deliver high current peaks in short period of time. During these peaks, the ripple voltage Vripp must be less than 50mVpp (for ripple frequency < 200KHz) or 2mVpp (for ripple frequeny > 200KHz) and the Drop Voltage Vdrop must be less than 100mVpp.



Supply voltage = 3.6V Minimum, 3V8 nominal, 4.2V absolute maximum.
Supply current = 2 amperes.

Current consumption in OFF mode: Nominal= 50µA, Maximum = 100µA

Current consumption in communication mode (assuming a 50Ω RF load):

- During Tx burst: Norminal = 1.7A peak, Maximum = 2A peak
- During Rx burst: Norminal = 75mA peak, Maximum = 80mA peak
- Average in communication: Norminal 300mA, Maximum = 400mA

Current consumption in idle: Norminal 4mA, Maximum = 7.5mA

5.3.2 SPI bus

Pin 30 = SPI_CLK
Pin 31 = SPI_EN
Pin 32 = SPI_IO

The SPI bus complies with the SPI bus standard. The maximum speed is 3.25Mb/s.
NOTE: The SPI bus is not yet implemented for AT command type of application.

5.3.3 Keypad interface

Pin 33 = Key row0	Pin 34 = Key column0
Pin 35 = Key row1	Pin 36 = Key column1
Pin 37 = Key row2	Pin 38 = Key column2
Pin 39 = Key row3	Pin 40 = Key column3
Pin 41 = Key row4	Pin 42 = Key column4

The modem provides scanning, debouncing functions. The key is reported using AT+CMER command.

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5.3.4 Serial link

The 8 wire serial link complies with the V.24 protocol but not with the V.28 (electrical interface) due to 3V logic.

Pin number	**I/O**	**Description**
Pin 11 (RTS)	In	Ready to Send
Pin 12 (DTR)	In	Data Terminal Ready
Pin 13 (RXD)	Out	Receive Data
Pin 14 (DSR)	Out	Data Set Ready
Pin 15 (TXD)	In	Transmit Data
Pin 16 (CTS)	Out	Clear To Send
Pin 17 (DCD)	Out	Data Carrier Detect
Pin 18 (RI)	Out	Ring Indicator

5.3.5 SIM interface

The GEM has already implemented a 3V SIM card on-board. These SIM signals are given to enable an external 3V-SIM card if required. A 5V SIM can also be implemented using an external SIM driver. Note that if an external SIM card is implemented, only one SIM card can be inserted at any one time.

Pin Number	**I/O**	**Description**
Pin 25 (SIM_PRES)	In	SIM card detect
Pin 26 (SIM_DATA)	In/Out	Bidirectional SIM data
Pin 27 (SIM_CLK)	Out	SIM clock
Pin 28 (SIM_RESET)	Out	SIM reset
Pin29 (SIM_VCC)	Out	SIM power supply

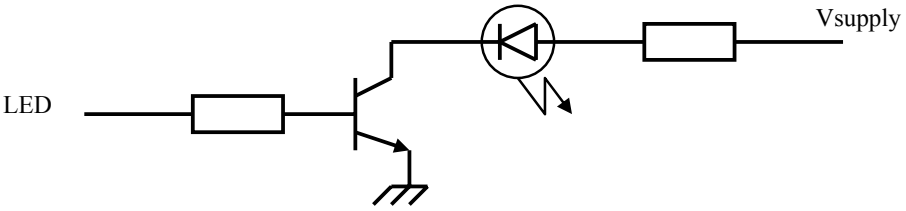
For SIM_PRES signal: when not used, tie to Vcc. When used, a low to high transition means that the SIM card is inserted. A high to low transition means that the SIM card is removed.

5.3.6 General purpose input / output

The GEM provides 3 digital input/output signals and 1 analogue input signal. The digital I/O signals associated with the AT+WIOR/AT+WIOW command. The 10bit analogue input (0V to 2.8V) associated with AT+ADC command (sampling rate is 90.3Ksps)

Pin 5 = AUXV0 Pin 20 = GPIO4 Pin 22 = GPIO5 Pin 23 = GPIO0

Pin 24 = LED: The LED output can be used to drive a LED indicator via a NPN transistor. The rate of flashing indicates different states that the modem is in.



LED on steady: Modem is on but has not register to the network.
Slow flash: Modem has registered to the network.
Rapid flash: Modem is in communication mode.

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5.3.7 Audio

5.3.7.1 Microphone:

The Microphone-2 inputs are differential. They include the biasing for an electret microphone (0.5mA and 2V). The electret microphone's impedance has to be around 2KΩ and can be connected directly.

Pin 7 = Microphone2 + Pin 9 = Microphone2 –

The gain of the Microphone input can be adjusted internally, from 30dB to 51dB, using the AT+VGT command.

AT+VGT=	Max Vin (mVrms)	Transmit gain (dB)
0 to 31	43.80	30
32 to 63	31.01	33
64 to 95	21.95	36
96 to 127	15.54	39
128 to 159	11.00	42
160 to 191	7.79	45
192 to 223	5.51	48
224 to 255	3.90	51

Recommended characteristics for the microphone:

- Type: Electret
- Impedance: 2KΩ to 3KΩ
- Sensitivity: -40dB to –50dB
- SNR > 50dB minimum

5.3.7.2 Speaker

The Speaker2 outputs are push-pull amplifiers and can be loaded down to 150Ω and up to 1nF. These outputs are differential and the output power can be adjusted by 2dB steps.

Pin 8 = Speaker2 + Pin 10 = Speaker2 –

The Speaker gain can be adjust internally using the AT+VGR command

AT+VGR=	Max Output Level	Max speaker load
0 to 15	1.74 Vrms	150Ω
16 to 31	1.38 Vrms	50Ω
32 to 47	1.099 Vrms	32Ω
48 to 63	0.873 Vrms	32Ω
64 to 79	0.693 Vrms	32Ω
80 to 95	0.551 Vrms	32Ω
96 to 111	0.437 Vrms	32Ω
112 to 127	0.347 Vrms	32Ω
128 to 143	0.276 Vrms	32Ω
144 to 159	0.219 Vrms	32Ω
160 to 175	0.174 Vrms	32Ω
176 to 191	0.138 Vrms	32Ω
192 to 207	0.110 Vrms	32Ω
208 to 223	0.087 Vrms	32Ω
224 to 239	0.069 Vrms	32Ω
240 to 155	0.069 Vrms	32Ω

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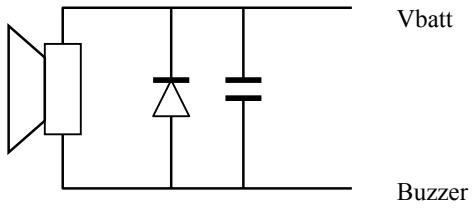
Recommended characteristics for the speaker:

- Type: 10mW, electro-magnetic
- Impedance: 32Ω to 150Ω / 1nF
- Sensitivity: 110dB SPL minimum (0dB=20µPa)

5.3.8 Buzzer output

The Buzzer output is a digital one. A buzzer can be directly connected between this output and supply voltage (3V6). The maximum peak current is 80mA and the maximum average current is 40mA. A diode against transient peak voltage is recommended.

Pin 6 = Buzzer output



Capacitor = 0 to 100nF depending on the buzzer type.

Recommended characteristics for the buzzer:

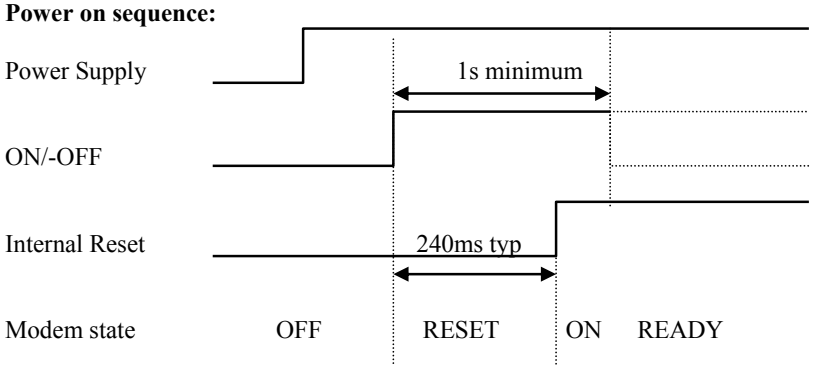
- Type: Electro-magnetic
- Impedance: 7Ω to 32Ω
- Sensitivity: 90dB SPL minimum @ 10cm
- Current: 60mA to 90mA

5.3.9 Control signals

5.3.9.1 ON/-OFF

Pin 2 = ON/OFF : This input is used to switch the modem on or off. A high level signal (3V6) has to be applied to this input for at least 1 second, to turn the modem on. The high signal can be left until modem is switched off. To properly switch the modem off, the On/-Off signal must be pulled to low and AT+CPOF command must be sent to the modem to deregister

Power on sequence:



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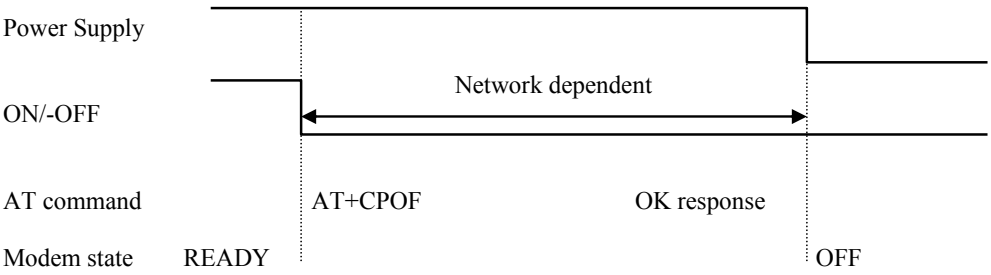
Power off sequence:

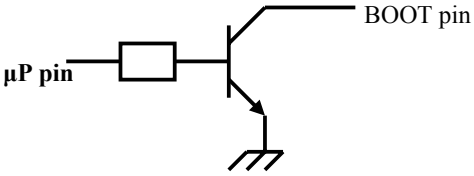


5.3.9.2 BOOT

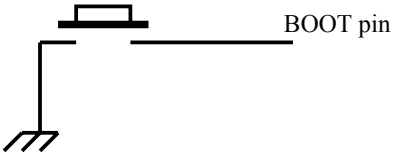
Pin 19 = BOOT input : This input is used to download the firmware into the modem's Flash memory. The internal boot procedure starts when this input is low during the modem reset. This input should be left open when not used. If used, it must be driven by an open collector/drain.

This is a back-up download procedure. The main download procedure is to use AT+WDWL command. (Refer to download procedure using AT command manual)

µP to drive BOOT signal



Manual activated



5.3.9.3 RESET

Pin 4 = RESET input: This input is used to force a cold reset by providing a low level for at least 100µS. This Reset signal has to be considered as an emergency reset only since a reset procedure is automatically done on power up.

If used, the Reset signal has to be driven by an open collector or open drain.

5.3.10 Real time clock supply

Pin 21 = VCC_RTC: This pin is used as a back-up power supply for the internal real-time clock when the modem is switched off. It can be left open if not used.

Requirements:

Input voltage = 2V minimum, 2.75V maximum
Input current = 10µA nominal

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6 General guide-lines

6.1 Hardware and RF

- The application main board shall have a common ground plane for analog, digital and RF.
- The track length of the extra SIM interface shall not exceed 15cm.
- Audio input/output shall have EMC protection (against 900MHz).
- ESD protection on the serial link
- Possible spurious emission from the application to the RF receiver in the receiver band.

6.2 Antenna

- Frequency band: Dual band E-GSM 900Mhz – GSM 1800MHz/GSM 1900Mhz

	EGSM 900	GSM 1800	GSM 1900
Rx band	925-960MHz	1805-1880Mhz	1930-1990MHz
Tx band	880-915Mhz	1710-1785Mhz	1850-1910MHz

- Impedance: 50Ω
- VSWR Tx max 2:1 / Rx max 2:1
- Typical radiated gain: 0dBi

The antenna should be isolated as much as possible from the digital circuitry.

6.3 Firmware upgrade

From time to time, a new firmware is available with extra features/functions. There are 2 ways to download the new firmware into the GEM's flash memory:

- Xmodem download: The GEM is connected to a PC's serial port, via the development board. A terminal program (eg. HyperTerminal) is used to download the new firmware.
- Boot download: This procedure is the back-up download if the Xmodem download is failed, due to interruption during download. This procedure must be carried by the modem distributor.

6.4 Minimum interface signals

The GEM can be operated with the following signals:

Pin number	**Signal**	**Description**
1,3	GND	Ground
2	On/-Off	Modem on/off
43,44	3V6	Supply Voltage
11	RTS	Ready To Send
13	RxD	Serial Data out of GEM
15	TxD	Serial Data into GEM
16	CTS	Clear To Send

6.5 Connectors parts

The apllication needs the following mating parts for the GEM

Main signal interface connector: SAMTEC 44 pin socket CLP-122-02-G-D-K or FLE-122-01-DV-K
Antenna connector: MMCX plug.

InterCEL Pty. Ltd. A.C.N. 007 077 161
33 Glenvale Crescent Mulgrave VIC. Australia 3170
Email : intercel@intercel.com.au
Internet : www.intercel.com.au
Ph: +61 3 9561 1666 Fax: +61 3 9561 2614

Additional documents

To successfully integrate the GEM in an application, the following documents are needed:

1) Wavecom AT command manual
2) Wavecom GPRS AT command
3) Wavecom GPRS User Guide
4) Downloading procedure (Firmware Upgrade)